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Polymetallic Sulfides: Law of the Sea Implications

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An Intelligence Memorandum

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GI 82-10085
April 1982

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Polymetallic Sulfides: Law of the Sea Implications [redacted] 25X

An Intelligence Memorandum

Information available as of 20 April 1982
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This paper was prepared by [redacted] 25X
[redacted] Office of Global Issues. Comments 25X
and queries are welcome and may be directed to
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Polymetallic Sulfides: Law of the Sea Implications [redacted] 25X

Key Judgments

The polymetallic sulfide deposits recently discovered along rifts in the sea floor of the eastern Pacific Ocean are a potentially large source of copper, zinc, silver, gold, platinum, and gallium and a less important source of other metals like iron, sulfur, and molybdenum. The current US policy interest in this discovery relates primarily to the attempt of some 150 nations at the Third UN Conference on the Law of the Sea (UNCLOS III) to forge a comprehensive treaty governing the exploitation of ocean resources lying in international waters. This week they will be discussing the moratorium on seabed mining that the United States objects to. [redacted] 25X

The present Draft Convention was largely developed before the polymetallic sulfide deposits were discovered and thus does not adequately treat their exploitation. The United States is seeking to revise the Convention to remove objectionable provisions concerning the mining of polymetallic nodules. Unless precise language is crafted for polymetallic sulfide mining, regulation would be left to unpredictable action by the International Seabed Authority established by the Convention, and exploitation of these resources would be hindered or delayed. [redacted] 25X

Cost estimates for polymetallic sulfide mining can be nothing more than guesses at this point because the technology for mining hard rock at depths of 2,000 to 3,000 meters is not yet developed. If current relative prices hold through the 1990s, only deposits with high gold, silver, and platinum content are likely to be of commercial interest and even these probably would not be mined before the turn of the century and thus are not likely to impact soon on world metal markets. [redacted] 25X

Early assays—and they are very preliminary—suggest that recovery of gold, silver, platinum, and gallium, even from only one or two polymetallic sulfide deposits rich in these metals, might disrupt one or more of their markets, lower prices, and adversely affect South Africa and the Soviet Union if the deposits are extensive. Markets for the other minerals mined would be much less affected. [redacted] 25X

Polymetallic sulfide mining would help those countries, including the United States, bordering the eastern Pacific. The West European countries and Japan are not as favorably situated with respect to known deposits, but might use their technological know-how in joint ventures with less developed nations. France, West Germany, and the United States appear to be the leaders in deep sea exploration and may be seen as possible

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leaders in mining polymetallic sulfide minerals. The United States has an advantage in hard-rock mining and deepwater dredging technologies that might be useful. [redacted] 25X

The Soviet Union would certainly want to keep its options open and may have an interest in mining polymetallic sulfide minerals. Wide publicity regarding these minerals may explain the increased Soviet interest in oceanographic research and mining technology and the more appreciative attitude the Soviets have toward the US position at UNCLOS III. [redacted] 25X

This week they gave their enterprises equal legal footing with their Western competitors by issuing a decree allowing them to make claims and initiate prospecting. If UNCLOS III fails to produce a treaty, Moscow may join the West in a reciprocating-states agreement on seabed mining. [redacted] 25X

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Polymetallic Sulfides: Law of the Sea Implications [redacted] 25

One of the significant shortcomings of the current Draft Convention on the Law of the Sea is the moratorium it would impose on the development of polymetallic sulfides, recently discovered metals in the international areas of the oceans. There is no question concerning jurisdiction over sulfide deposits or other resources falling within 200 miles of land, for they would clearly be the property of the coastal state. The Draft Convention does not expressly prohibit the development of sulfide deposits by name, but it does not allow development until such time as the proposed International Seabed Authority is established and then adopts rules and regulations governing the development of minerals other than polymetallic nodules. This moratorium and the flawed texts on mining nodules have been identified as the major segments of the treaty text in need of revision if the LOS treaty is to be signed and ratified by the United States. [redacted] 25

Metals of Primary Interest

The first deposit of polymetallic sulfides was discovered in 1978 by a joint French-American-Mexican exploration of the East Pacific Rise, a seafloor ridge located off the western coast of Latin America. Since that initial discovery, deposits of these minerals have been found at other sites along this ridge and on the Juan de Fuca Ridge off the coast of the state of Washington. Marine geologists are confident that additional deposits occur at selected sites along the fast- and medium-fast-spreading portions of the entire 72,000-kilometer globe-encircling midocean ridge. They increasingly suspect that deposits also lie along lesser rifts in the Western Pacific. These latter deposits, however, are deeper and covered with sediment, making them less accessible. [redacted] 25

All of the known deposits appear to be important because of the variety and high content of the minerals each contains as compared to alternative land-based mineral deposits. Each deposit is rich in sulfur and iron, and one or more have been found to contain relatively high concentrations of copper, zinc, silica, silver, gold, platinum, molybdenum, and gallium. The existence of deposits rich in still other metals cannot be ruled out. Development of any one deposit, therefore, may provide more efficient access to a wide variety of important metals than would exploitation of corresponding land-based resources. However, because little is known of the extent of the polymetallic sulfide deposits, the cost of exploiting them,

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Plate Tectonics and Polymetallic Sulfides

The theory of plate tectonics, developed in the 1960s, postulates that the earth's crust is composed of a dozen or so thin, rigid, adjoining plates that are in constant motion—thrusting against, grinding, and overriding one another like polar ice flows. Certain of these plates adjoin at the midocean ridge where they move away from one another at varying rates. The East Pacific Rise and the Mid-Atlantic Ridge are segments of this structure. Molten rock, the source of the sulfide deposits, rises from the earth's depths to the surface of the seabed, adhering to the edges of the diverging plates and forming new crust. After it hardens, the new crust is fractured and faulted by the stress of plate movement, particularly where the seafloor is spreading at medium to fast rates (6 to 18 cm per year). Seawater is heated to nearly 400 degrees Celsius as it percolates downward along these fractures toward the chamber of molten rock. This superheated water then rises, dissolving minerals from the newly formed crust as it goes. Contact with the cold water at the surface of the seafloor, precipitates the dissolved minerals as metallic sulfides along the flanks of the midocean ridge.

The first discovery of these sulfides came as a surprise in 1978. Subsequent expeditions were planned, based on an understanding of the natural processes that formed such deposits. In addition to the finds on the Juan de Fuca Ridge about 250 miles west of the state of Washington, near Easter Island, and just south of Baja California, deposits have been charted on the Gorda Ridge about 85 miles west of Oregon, in the Guaymas Basin in the Gulf of California, on the East Pacific Rise east of Clipperton Island, and in the Galapagos Rift. The last deposit, located at a depth of 2,500 meters in the finger of international seabed that separates the 200-mile economic zones off Ecuador's mainland and the Galapagos Islands, is the most massive. Estimated to be 40 meters thick, 300 meters wide, 1,000 meters long, and 25 million tons in weight, it contains perhaps $2 billion worth of copper and lesser amounts of other metals, including silver, cadmium, iron, molybdenum, lead, tin, vanadium, and zinc.

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or the political-economic environment in which exploitation would occur, the economic potential of this resource is uncertain. A few judgments seem clear:

- The iron and silica are economically unimportant because of their low concentration compared to that found in widespread land-based sources.
- Sulfur would be extracted only as a byproduct to minimize pollution in the processing of the sulfides.
- The copper, zinc, and molybdenum, although also widely available elsewhere, have large markets, could be easily processed, and therefore would be among the metals exploited if polymetallic sulfide mining proves to be cost effective. 25

The main interest in polymetallic sulfide ores is likely to center on the precious metals (gold, silver, and platinum), vanadium, and gallium:

- Gallium, now available only in limited quantities, is used primarily in electronic devices and is being developed as a possible substitute for silicon in chips for integrated circuits.
- Recovery of gold and platinum from large deposits rich in these metals, could well be profitable even if investment and operating costs were relatively high.
- Silver would be important but to a far lesser extent.

Moreover, because platinum and to a lesser extent vanadium have strategic uses, their extraction from polymetallic sulfide ores would be especially important. 25

The Legal Regime

Ocean resources will be mined under two legal regimes, a national regime for deposits lying within a nation's 200-mile coastal economic zone and an international regime for deposits lying beyond the zone. However, the international regime has yet to be established. The Third UN Conference on the Law of the Sea (UNCLOS III) has been negotiating a seabed regime since 1972 that would put all exploitation of seabed minerals lying beyond national jurisdiction under the control of a proposed International Seabed Authority (ISA). 25

The provisions for mining polymetallic nodules under this controversial regime, as embodied in the Conference's Draft Convention on the Law of the Sea, are presently unacceptable to most industrial states because of the requirements for burdensome revenue sharing, technology transfer, and production limits coupled with uncertainties regarding control over ISA decisions. The Draft Convention is further flawed because it deals specifically only with exploitation of the polymetallic nodules; the only hard minerals of the seabed known when UNCLOS III began. Additionally, the Draft Convention would implicitly establish a moratorium on the development of polymetallic sulfide deposits. 25

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The current seabed texts would prohibit the development of seabed resources other than polymetallic nodules until specifically regulated by the ISA. First, the texts define all solid, liquid, or gaseous mineral resources at or beneath the seabed in the international areas of the oceans as the "common heritage of mankind," thus assuring that they come under the domain of the ISA. Elsewhere, it is made clear that until the Seabed Authority adopts rules and regulations governing exploration for and exploitation of the various classes of resources, it cannot accept or process mining applications for those resources, thus effectively blocking their development. To make matters worse, the Authority would be granted the right to limit the levels of production of such minerals as polymetallic sulfides when and if it ever allowed commercial extraction to commence.

[redacted] 25X

Developing countries are as concerned as the United States about these minerals because, even if not affected by nodule production, they might benefit or be harmed by the eventual discovery and possible exploitation of other minerals. It is safe to assume that, although the issue of the moratorium has received far less attention at the Conference than the nodule question, it would be equally difficult to correct. Failing agreement on a comprehensive oceans treaty, industrialized states which possess the capital and can develop the technology required to exploit such resources might have to turn to an alternative legal strategy such as a minitreaty to serve as the underpinning for polymetallic sulfide mining. As in the case of the proposed Reciprocating States Agreement for nodule mining among the United States and other industrial nations, such a course would be strongly criticized and perhaps challenged legally by the developing countries. [redacted] 25X

The Realities of Mining Polymetallic Sulfides

Even if these institutional problems were resolved rapidly, polymetallic sulfide mining would not be likely to occur soon. Three to five more years of basic research are needed before the size and richness of this resource can be determined. Exploration of specific minesites by interested parties would normally also take three to five years. Development of the mining technology could start at the same time but, under normal conditions, would not be completed before the mid-1990s. Until then, commercial enterprises would not be able to make final decisions on specific minesites they wish to exploit, the methods of recovery, the most economic operating scale, the location of processing facilities, and other options. Another five or six years might subsequently be required to assemble the necessary capital equipment and facilities. As a result, the first commercial exploitation of polymetallic sulfide deposits would not be likely to occur before the end of the century. [redacted] 25X

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This timetable would be further delayed if any conflict developed in the creation of the legal-political framework needed or if the return on investment appeared insufficient. In either case, investors would continue to exploit available land-based mineral deposits offering attractive rates of return. Platinum and vanadium are often considered of strategic importance, but government assistance to ocean sulfide mining to obtain them would depend on the status of their continued availability from existing land-based sources. [redacted] 25

Given the recovery rates attainable with current processing technology (75 to 90 percent) and the lower price levels likely to result from marketing the polymetallic sulfide metals, only those deposits high in precious-metal content would be likely to attract commercial interest. These, however, might be so profitable to exploit that commercial development could proceed more rapidly than usual, even in the face of relatively high costs and reduced metal prices, if the legal-political framework were favorable. [redacted] 25

Mining

The capital and operating costs of mining and transporting the polymetallic sulfide ores will depend greatly on the technology used. Some of the equipment and techniques required may already be available, but they have not been tested at the depths involved. More likely, an entirely new technology would have to be developed from scratch to meet the needs of mining hard rock at depths of 2,000 to 3,000 meters in the open ocean. Given these conditions and the environmental limitations that may be imposed, the capital and operating costs of mining polymetallic sulfide deposits would probably be great. [redacted] 25

Although current estimates of the cost of mining polymetallic nodules from the seabed are very tentative and involve totally different minerals, techniques, and equipment, they may provide some perspective on costs of mining and transporting the polymetallic sulfide minerals. A 3-million-ton-per-year nodule operation is likely to require around $200 million in preinvestment costs, some $300 million in capital costs, and $50 million in annual operating expenses for mining and transportation alone.[1] While this involves the movement of four to five times the material that would be handled by a 1-million-ton-per-year polymetallic sulfide operation, the latter is likely to be more difficult because it involves drilling or blasting into rock at great depths. [redacted] 25

[1] For a fuller description of the estimates made to date of polymetallic nodule mining, see *The Seabed Mining Alternative: Problems and Prospects*, (Confidential), GS 81-10191, August 1981. (U)

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Mining Polymetallic Nodules Versus Polymetallic Sulfides

Exploiting polymetallic nodules or sulfides involves basically similar tasks—prospecting and exploration, technology development, capital investment, and operations. The last includes collecting the materials on the seafloor, raising them to the surface, transporting them to processing facilities, and extracting the desired metals from the ores.

The problems that must be solved in the two projects, however, are quite different. The nodules are potato-size lumps of minerals scattered on or buried slightly below the surface of vast areas of the ocean floor. They must be scooped up in some systematic way. Because the nodules are small, they can be raised in a steady stream, either by pipe or bucket, or stored until an appreciable quantity is collected and then raised by a vehicle or lifting device. Few environmental problems are foreseen with this part of the operation. Nevertheless, the technology required can get quite involved; it has been under development for more than a decade and is still not perfected. Once raised, the nodules would be transported in a slurry to shore processing facilities. Because the desired metals—copper, nickel, cobalt, and manganese—are tied up in oxides, modifications of existing techniques and new approaches are being developed to extract them. They are costly and represent the major portion of the total cost of exploiting polymetallic nodules.

The sulfide deposits, on the other hand, are either crusts or blocks of rock located close to rifts in the ocean floor. Hence, they may be approached much as a conventional land-based ore deposit, except that they lie at depths of 2,000 to 3,000 meters in the open ocean. Lifting the ore to the surface may require blasting or other procedures for breaking up the rock. This may create environmental problems. In any case, the methods and equipment needed to collect and raise sulfide minerals to the surface are probably not available and would have to be developed.

Once on the surface the sulfides must be transported to shore facilities, a process that should pose no problem. Neither would the extraction of the minerals. Inasmuch as the sulfide ores are quite similar to those found in land-based deposits that have been exploited for years, the necessary technology is already available. Very possibly the polymetallic sulfide metals could be extracted in existing smelters and refineries, thus minimizing the capital investment needed. This would more likely be true of US, Canadian, and Japanese mining. Other interested parties may have to invest in facilities in countries bordering the Eastern Pacific or make arrangements for their ore to be toll-processed in existing facilities in these countries.

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Processing

The technology needed to process the polymetallic sulfide ores is available. These ores are similar to sulfides from land-based sources that have been exploited for centuries. Indeed, it may be possible to smelt and refine the metals in existing facilities, thereby forgoing the need for expensive capital investment. That is, it may well be cheaper to transport concentrate to existing facilities in the United States than to build new ones in Hawaii, Mexico, Peru, Chile, or on a Pacific island. 25

Market Impact

The only certainty with respect to polymetallic sulfide mining is that it is quite probably a long way off and will not be a source of metal to supplement land-based supplies in the near future. Judgments with regard to the market impact of any mining ventures are therefore of necessity tentative. It is likely, however, that when the appropriate technology is commercially available and the legal regime has been satisfactorily resolved, attention will focus first on those deposits both large and high in precious-metal content. The amount of precious metals likely to be obtained might make a mining venture economically attractive even if the venture were expensive and the increased supply of precious metals were sufficient to weaken the markets for those metals. 25

Indeed, the recovery of gold, silver, and platinum from deposits high in their content would likely drive prices down. The producers of silver—which today include the United States, Canada, Mexico, Peru, Poland, the Soviet Union, and Australia—would be adversely affected. However, silver output represents only a small part of all economic activity in these countries and is likely to diminish in importance over the next two decades. Therefore, while individual interests might be damaged by polymetallic sulfide silver output, no one country would be hurt significantly. As regards gold and platinum, the market impact of polymetallic sulfide mining could have negative consequences for both South Africa and the Soviet Union. Gold production is the largest single economic activity in South Africa—in 1979 accounting for some 12 percent of gross domestic product, 38 percent of all exports, and 74 percent of the trade surplus and making the difference between a large deficit and a large surplus in the country's current account. In 1981 gold sales of more than $2.5 billion amounted to over 60 percent of the USSR's hard currency deficit. 2

Along with the precious metals, a mining venture could produce a quantity of other metals such as gallium, copper, zinc, molybdenum, and vanadium. Expansion of the supply of gallium could lead to major new uses for this rare metal. For example, it could replace silicon in the integrated chips needed for high-speed computational devices. The markets for the other metals would be affected only if the ore content were relatively high and the number of minesites worked were very large. In this case the prices of

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these metals would decline to some extent, perhaps even forcing the closing of some of the higher cost private land-based mines for these metals. In the copper industry these would be primarily in the United States, Australia, and Peru. However, a lower price would benefit consumers, most of whom are in the advanced industrial countries. [redacted] 25X

The United States, France, and West Germany are the leaders in research on midoceanic ridges and polymetallic sulfide deposits. They would most likely lead the way in developing the technology necessary to exploit these deposits. The West European countries, not well situated for such exploitation, would probably form joint ventures with countries that border the Pacific—such as Mexico, Chile, Venezuela, Peru, or Ecuador—in order to minimize transport costs and take advantage of local energy resources. These latter countries, along with Canada, are almost certain to find their mineral industries enhanced by the exploitation of polymetallic sulfide deposits along the East Pacific Rise. Mexico and Ecuador would especially benefit by reason of their proximity and the energy resources that they could contribute to the processing of the polymetallic ores. [redacted] 25X

US Interests

Polymetallic sulfide deposits are of current interest primarily because of the role they might play in the present Law of the Sea debates. If the Conference does not craft a clear text on the mining of these metals, a Draft Convention could go into the lengthy ratification process without polymetallic sulfide mining rules and regulations. These would have to be added by amendment later, and mining could be delayed until their adoption. [redacted] 25X

The US lead in hard-rock mining and deepwater dredging technologies might afford it an important advantage in the exploitation of polymetallic sulfide minerals. But environmental considerations are likely to discourage any processing of these ores on the west coast, and transport to facilities in the interior may be costly. The latter are old and themselves environmentally troublesome. Metal markets have not been robust enough to warrant costly pollution control programs, and copper and zinc companies claim that they will close their smelters and refineries, shifting this processing to other countries, rather than retrofit them. If the more highly profitable ocean sulfide deposits are exploited, the copper and zinc extracted as a byproduct might help revitalize these US industries. Also, exploitation of polymetallic sulfide minerals could considerably reduce or eliminate US dependence on imports of many of the metals found in the deposits, including, in the case of platinum and vanadium, a potentially dangerous reliance on South Africa and the Soviet Union. [redacted] 25X1

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The United States and its allies could find the Soviet Union a well-prepared competitor in mining ocean sulfides. The Soviet Union is largely self-sufficient in the metals found in the polymetallic sulfide deposits.

25X1 [redacted]

[redacted] Moreover, the USSR has also recently

25X1 adopted a slightly more favorable attitude toward US objections concerning the current LOS Draft Convention. There are even indications that the USSR might not accede to the Convention unless the Western industrial countries and Japan do so. At this time Moscow's principal interest is probably to preserve its options with respect to any minerals that might be available from the seabed. [redacted] 25X

The Soviet decree on seabed mining issued this week allows its enterprises to stake claims to seabed mineral deposits lying in international waters; prospecting and mining will not be allowed until 1 January 1988. By this act, the Soviets are putting themselves on an equal footing with the industrial nations that have already adopted similar national legislation. Now, Soviet firms may establish property rights as Western firms may now do. If UNCLOs III fails to produce a treaty, Moscow might join the West in a reciprocating-states agreement. [redacted] 25X

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